

ClaimsWhat is claimed is:

1. A process for producing an alkali metal comprising electrolyzing an electrolyte, which comprises or is produced by combining at least one alkali metal halide and a co-electrolyte wherein said co-electrolyte comprises (1) at least one halide selected from the group consisting of Group IB halide, Group IIIA halide, Group VIII halide, and combinations of two or more thereof and (2) a halide-donating compound, which is capable of reacting with a Lewis acid by donating a halogen atom.
2. A process according to claim 1 wherein said process is carried out under a condition in which a molten layer of said alkali metal is produced.
3. A process according to claim 2 wherein said process is carried out at a temperature below about 200 °C, but is higher than the melting point of said alkali metal.
4. A process according to claim 1 wherein said at least one halide is selected from the group consisting of aluminum halide, boron halide, antimony halide, iron halide, cobalt halide, nickel halide, and combinations of two or more thereof.
5. A process according to claim 1 wherein said halide-donating compound is RSO_2X , $\text{RP}(\text{O})\text{X}_2$, or combinations thereof; R is $-\text{CX}'_3$, $-\text{N}=\text{PX}_3$, $-(\text{CX}_2)_n\text{CX}_3$, or combinations of two or more thereof; X is halogen; X' is hydrogen, halogen, or combinations thereof; and $n = 3 - 7$.
6. A process according to claim 1 wherein said halide-donating compound is RSO_2X , $\text{RP}(\text{O})\text{X}_2$, or combinations thereof; R is $-\text{CX}'_3$, $-\text{N}=\text{PX}_3$, $-(\text{CX}_2)_n\text{CX}_3$, or combinations of two or more thereof; X is halogen; X' is hydrogen, halogen, or combinations thereof; and $n = 3 - 7$.
7. A process according to claim 3 wherein said halide-donating compound is RSO_2X , $\text{RP}(\text{O})\text{X}_2$, or combinations thereof; R is $-\text{CX}'_3$, $-\text{N}=\text{PX}_3$, $-(\text{CX}_2)_n\text{CX}_3$, or combinations of two or more thereof; X is halogen; X' is hydrogen, halogen, or combinations thereof; and $n = 3 - 7$.

8. A process according to claim 4 wherein said halide-donating compound is RSO_2X , $\text{RP}(\text{O})\text{X}_2$, or combinations thereof; R is $-\text{CX}'_3$, $-\text{N}=\text{PX}_3$, $-(\text{CX}_2)_n\text{CX}_3$, or combinations of two or more thereof; X is halogen; X' is hydrogen, halogen, or combinations thereof; and $n = 3 - 7$.

5 9. A process according to claim 8 wherein said halide-donating compound is selected from the group consisting of methanesulfonyl chloride, trichlorophosphazosulfonyl chloride, trichlorophosphazophosphoryl chloride, trichlorophosphazosulfonyl chloride, and combinations of two or more thereof.

10 10. A process according to claim 9 wherein said co-electrolyte comprises aluminum chloride and methanesulfonyl chloride.

11. A process according to claim 9 wherein said co-electrolyte comprises aluminum chloride and trichlorophosphazosulfonyl chloride.

15 12. A process according to claim 9 wherein said co-electrolyte comprises aluminum chloride and trichlorophosphazophosphoryl chloride.

13. A process for producing an alkali metal comprising electrolyzing an electrolyte, which comprises at least one alkali metal halide and a co-electrolyte wherein said co-electrolyte comprises (a) at least one halide selected from the group consisting of Group IB halide, Group IIIA halide, and Group VIII halide and (b) a halide-donating compound wherein

said process is carried out under a temperature below about 200°C ;

said process is carried out such that a molten layer of said alkali metal is produced;

25 said at least one halide is selected from the group consisting of aluminum halide, boron halide, antimony halide, iron halide, cobalt halide, nickel halide, and combinations of two or more thereof; and

said halide-donating compound is RSO_2X , $\text{RP}(\text{O})\text{X}_2$, or combinations thereof; R is $-\text{CX}'_3$, $-\text{N}=\text{PX}_3$, $-(\text{CX}_2)_n\text{CX}_3$, or combinations of two or more thereof; X is halogen; X' is hydrogen, halogen, or combinations thereof; and $n = 3 - 7$.

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14. A process according to claim 13 comprising raising said temperature to higher than the melting point of said alkali metal if said temperature is below the melting point of said alkali metal.

15. A process according to claim 14 wherein X or X' is chlorine.

5 16. A process according to claim 15 wherein said halide-donating compound is selected from the group consisting of methanesulfonyl chloride, trichlorophosphazosulfonyl chloride, trichlorophosphazophosphoryl chloride, trichlorophosphazosulfonyl chloride, and combinations of two or more thereof.

10 17. A process according to claim 15 wherein said co-electrolyte comprises aluminum chloride and methanesulfonyl chloride.

18. A process according to claim 15 wherein said co-electrolyte comprises aluminum chloride and trichlorophosphazosulfonyl chloride.

15 19. A process according to claim 15 wherein said co-electrolyte comprises aluminum chloride and trichlorophosphazophosphoryl chloride.

20. A process according to claim 17 wherein said alkali metal is sodium and said alkali metal halide is sodium chloride.

21. A process according to claim 18 wherein said alkali metal is sodium and said alkali metal halide is sodium chloride.

20 22. A process according to claim 19 wherein said alkali metal is sodium and said alkali metal halide is sodium chloride.

25 23. A process for producing sodium comprising electrolyzing, in an electrolytic cell, an electrolyte comprising (1) sodium chloride and (2) a co-electrolyte selected from the group consisting of (a) aluminum chloride and methanesulfonyl chloride, (b) aluminum chloride and trichlorophosphazosulfonyl chloride, (c) aluminum chloride and trichlorophosphazophosphoryl chloride, (d) aluminum chloride and trichlorophosphazosulfonyl chloride, and (e) combinations of any two of (a), (b), (c), and (d) wherein said process is carried out under a
30 temperature below about 200°C.

24. A process according to claim 23 wherein said process is carried out under a condition such that a layer of molten sodium is produced at the cathode and halogen is produced at the anode of said cell.

5 25. A process according to claim 24 comprising raising said temperature to higher than the melting point of said alkali metal if said temperature is below the melting point of said alkali metal.

26. A process according to claim 25 further comprising removing said layer of molten sodium from said cell.

10 27. A process according to claim 26 further comprising separating said sodium alkali metal thereby optionally producing a recovered electrolyte.

28. A process according to claim 27 further comprising recycling said recovered electrolyte.

15 29. A process according to claim 28 wherein said electrolyte comprises said sodium chloride, said aluminum chloride, and said methanesulfonyl chloride.

20 30. A process according to claim 28 wherein said electrolyte comprises said sodium chloride, said aluminum chloride, and said trichlorophosphazosulfonyl chloride.

31. A process according to claim 28 wherein said electrolyte comprises said sodium chloride, aluminum chloride, and said trichlorophosphazophosphoryl chloride.